Architectural distortion of the breast: the best way to confront it

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Abstract
Objective: To determine with which imaging method it is possible to better visualize and characterize an architectural distortion (AD) of the breast. Material and method: A retrospective study, approved by the Ethics Committee. Mammographic studies, with a diagnosis of architectural distortion (AD) in our center between August 2015 and August 2016, were selected. Included were cases studied with at least 3 of the available PACS imaging modalities: digital mammography (2D), tomosynthesis (TS), ultrasound (US), magnetic resonance (MRI) and which were biopsied at our institution. AD cases associated with micro-calcifications and post-surgical changes were excluded. The detection rate, imaging characteristics and the histopathological concordance were evaluated. Results: In 15 months, 81 cases of AD were detected via mammography; of these, 52 met the inclusion criteria. According to the histopathology, 23 (44%) were malignant, 17 (33%) were benign and 12 (23%) were high-risk lesions (HRL). All were detected with TS and US, and classified as suspicious lesions (BI-RADS 4 or 5). In 2D mammography, 24 cases (46%) were hidden, and of these, 8 (33%) were malignant. The malignant lesions presented a dense center in 87% of the cases. The most frequent lesion on ultrasound was the hypoechoogenic area (60%), in 86% of the lesions with penetrating vessels. There were 21 MRI, with mass type uptake being identified in the malignant pathologies. Conclusion: AD of the breast is best viewed in TS than in 2D mammography. Despite its characteristics, a histological study is indispensable (even when a radiolucent center is observed). Directed US is the next step, since it allows visualization of the lesion and the guiding of its percutaneous biopsy in majority of cases.

Keywords: Tomosynthesis; 2D Mammography; Architectural distortion; Infiltrating ductal cancer; Radial scar

Introduction
Architectural distortion (AD) of the breast has been described by the American College of Radiology (ACR) in the Breast Imaging Reporting and Data System (BI-RADS) as follows: “Appearance in which the normal architecture of the breast is altered by an invisible mass. This includes spicules radiating from a point, focal retraction or distortion of the parenchyma edge”. AD is the third mammographic manifestation of non-palpable breast cancer and is the most commonly undiagnosed anomaly in mammography, being the cause of false negatives.

Although the main objective of the detection of AD is to identify malignant tumors, the benign causes can be shown with an appearance similar to that of malignancy and it is necessary to recognise them. The most common benign cause is mammary fibrosis; within the high risk lesions (HRL), radial scars, and in the malignancies, invasive ductal carcinoma (IDC).

The mammographic findings characteristic of
the radial scar are long and thin radiating spicules with parallel radiotransparencies, radiolucent central zone and variation in the visibility between the mammographic projections because of their flattened morphology\(^{[4]}\). Unlike breast cancer, radial scars are smooth in texture and have little or no cutaneous retraction. They have a central sclerotic nucleus of acellular connective tissue (fibrosis) and elastin deposits (elastosis). If ducts are trapped inside the sclerotic nucleus, these show an intact myoepithelial layer, unlike carcinomas. The peripheral part of the scar may contain deformed ducts and lobules, ductal hyperplasia, fibrocystic changes and papillomatosis\(^{[5]}\).

Many of these mammographic findings are subtle. On the contrary, the “typical” mammographic feature described for invasive carcinoma is a dense homogeneous central mass with an ill-defined spiculated margin. These spicules are shorter than the diameter of the mass and broad based\(^{[4,8]}\).

The tomosynthesis (TS) reduces structured noise that limits 2D mammography and facilitates the identification of mammographic findings, including architectural distortion. With its use, ADs are often seen more clearly, even those that may be hidden in 2D. In 2D mammography, 12% to 45% of omitted cancers are distortions\(^{2}\). In a recent small study, AD was more easily identified with TS than with 2D mammography, with 73% of the distortions identified only with TS, and of which 21% were diagnosed as cancer\(^{[2]}\).

The suspicion of malignancy in an AD increases if it is associated with a mass, but sometimes this is not visible in 2D. With the TS technique the central portion of an AD that may represent a mass, can be observed; however, occasionally radiolucency is observed, as some malignant tumors can trap fat\(^{[2]}\).

**Objective**

To evaluate with which mammographic method the architectural distortion of the breast is best detected.

**Material and method**

Retrospective descriptive study, approved by the Ethics Committee of the institution.

The original studies performed consisted of digital mammography images (2D) taken in 2 projections (mediolateral oblique and craniocaudal), as well as TS reconstructions in both projections. 2D and TS images were obtained on a 3D mammography equipment (Selenia Dimensions, Hologic) during a single compression for each projection. The TS images were obtained via the arc motion of the X-ray tube at +15\(^{\circ}\) and -15\(^{\circ}\), which were reconstructed in 1 mm sections. The studies were interpreted independently in a workstation (SecurView, Hologic).

Using the Mammogram Imaging Service database, mammographic studies with a diagnosis of AD between August 2015 and August 2016, were selected. Cases involving at least 3 of the imaging modalities available in the PACS system (Picture archiving and communication system) were included: digital mammography (2D), tomosynthesis (TS), ultrasound (US) or magnetic resonance imaging (MRI), and which also have a histological study performed at our institution. Cases of AD associated with micro-calcifications were excluded.

We analyzed the detection rate of AD in each study method, its imaging characteristics and its histopathological concordance. An ad hoc database was created in Excel with the variables of interest.

**Results**

In 24 months of study, 81 cases were detected, of which 52 met the inclusion criteria. The median age of the included patients was 48 years (range: 27-79 years).

According to the histopathology report of the 52 cases, 23 (44%) AD were malignant, 17 (33%) were benign and 12 (23%) were HRL (Table 1). The most frequent benign lesion corresponds to stromal fibrosis, and the most common HRL was the radial sclerosing lesion (RSL). Among the malignant cases, IDC predominates (Figure 1).

| Table 1. Overall histological results of architectural distortions (AD) of the breast. |
|---|---|---|
| Pathologies | n | % |
| **Benign** | | |
| Stromal fibrosis | 6 | |
| Fibrosis and adenosis | 2 | |
| Fibrosis and pseudoangiomatous stromal hyperplasia | 1 | |
| Fibromatosis | 1 | |
| Nodular adenosis | 1 | |
| Post-surgical changes | 1 | |
| Proliferative lesion without atypia | 1 | |
| Chronic inflammatory process | 1 | |
| Fibrocystic changes | 2 | |
| Normal tissue | 1 | |
| **HRL** | 23 | |
| RSL | 8 | |
| LIN 2 | 1 | |
| LIN 3 | 1 | |
| Intraductal Papilloma | 2 | |
| **Malignant** | 44 | |
| IDC | 18 | |
| CLI | 4 | |
| DCIS | 1 | |
| **Total** | 52 | 100 |
52 AD were analyzed in 52 patients; they all had 2D, TS and US performed. All the lesions visualized were classified as suspicious findings (BI-RADS 4 or 5). AD was detected in all TS and US studies; however, it was only observed in 54% of 2D mammograms. In 2D there were 24 (46%) hidden lesions, all identified in TS. Of these, 8 (33%) correspond to malignant lesions (Figure 2). In addition, the malignant lesions had a dense center in 87% of the cases (20/23) (Figure 3). However, there are architectural distortions that, regardless of their etiology, present a dense center.

All the lesions were detected in US and presented suspicious morphological characteristics (BI-RADS 4 and 5), a hypoechogenic area (Figure 4) being the most frequent finding.

Color Doppler evaluation showed that the benign lesions were mainly avascular (70%); the lesions with penetrating vessels were mostly malignant (86%).

Of the 21 MRIs available, 18 were performed on patients with malignant histological results; all the lesions were visualized by this technique, and the majority presented mass-type uptake (78%).

Figure 1. A) The 2D digital mammography shows architectural distortion with dense-center and short spicules whose histologic study revealed infiltrating ductal carcinoma (IDC). B) Radiolucent center in architectural distortion corresponding to radial scar according to pathological anatomy. C) Stromal fibrosis of the breast shown as architectural distortion, with best visibility in the study with tomosynthesis. A- IDC B- Radial lesion C- Stromal fibrosis

Figure 2. A) Digital mammography craniocaudal projection (CC) of the left breast with heterogeneously dense tissue (ACR C), with no evidence of focal lesions. B) Tomosynthesis slice in left CC projection of the same patient, showing architectural distortion of 15 mm hidden in 2D, whose histological study revealed grade II IDC.
Discussion

In many cases AD can be a subtle finding, which makes it difficult to detect in 2D mammography, generating false negative results for this imaging technique. In literature, it is described that up to 73% of AD are only visualized in TS\(^{(4)}\). In our series, we demonstrated that TS is superior to 2D mammography for the detection of AD, since the latter conceals the lesions in 46% of cases. Note that of all hidden lesions in 2D (24/52, 46%), a significant percentage were malignant lesions (8/24, 33%). These cases corresponded to lesions smaller than 1 cm and developed in heterogeneously dense breasts ACR C.

The differential diagnosis of the AD includes benign and malignant pathologies. In this study, 44.23% of the AD corresponded to cancers, mainly of infiltrating type (78.2%). Among the HRLs (12 cases) RSL predominated (80%), and among the benign lesions (17 cases) the most frequent histological finding was stromal fibrosis (66%).

Regarding the mammographic characteristics of AD, typically some characteristics that have a tendency toward malignancy have been described, such as the presence of a dense center\(^{(5)}\), which coincides with our series, where it was identified that 87% of the malignant lesions presented a dense center. However, a small percentage of cancers (3/23, 13%) had a radiolucent center, meaning entrapped fat, so this characteristic does not confirm benignity, as already described in other publications.

In our series, all the AD were identified in US performed as a complement to the mammographic study to better characterize the lesion already visualized by 2D and/or TS.

The TS locator bar helps to identify visible distortions in a projection or small distortions to later locate them with directed US. Neither were imaging characteristics demonstrated that confirmed or ruled out malignancy; however, the use of color Doppler was a guide\(^{(7)}\), since 86% of lesions with penetrating vessels were malignant.

All malignant AD were visible in MRI, mainly as a mass-type lesion, a study usually performed in the preoperative period at our institution. There were 3 cases with benign histological results that had complementary studies with MR for radiohistological discordance (fibrosis, LIN2 and RSL), and none demonstrated pathological focal uptake of gadolinium.

Figure 3. Architectural distortions of the breast. A) Dense center in IDC shown as AD in 2D digital mammography. B) Architectural distortion of the breast visible only in TS with histological result of IDC that presents dense center. C) Radiolucent center observed in AD, best identified in TS, compatible with RSL. D) RSL with dense center that presents as AD seen in TS.

Figure 4. Ultrasonic representation of architectural distortion. A) Hypoechogenic nodule with irregular morphology, posterior acoustic shadow and penetrating vessels corresponding to IDC. B) Hypoechogenic area with non-circumscribed margins resulting in nodular adenosis. C) RSL shown by architectural distortion with posterior acoustic shadow. D) Significantly hypoechogenic area with spiculated margins and posterior acoustic shadow that demonstrates stromal fibrosis of the breast.
Conclusion
The primary study for detecting AD is 2D digital mammography. However, TS has been shown to have a higher detectability rate. In our study, almost half of the lesions were hidden in 2D mammography, with a significant percentage of them being malignant (33%). The visualization of AD with US is high, it helps to confirm, characterize and guide the biopsy by this method. Magnetic resonance imaging is useful in cases of radio-histological discordance. Unequivocal imagery characteristics for benignity or malignity in architectural distortions do not exist, so it is indispensable to study them histologically.

Ethical Responsibilities
*Protection of people and animals.* The authors declare that no human or animal experiments have been performed for this research.
*Confidentiality of the data.* The authors declare that they have followed the protocols of their work center regarding the publication of patient data.
*Right to privacy and informed consent.* The authors declare that no patient data appears in this article.

Funding
No source of funding.

Conflict of interests
No conflicts of interest.

Acknowledgments
Thanks to the Breast Imaging Services team of the Clínica Alemana de Santiago.

Bibliography